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March 6, 2017

To: Iowa General Assembly
From: John D. Lawrence
Re: Progress report on 2015 SF494 sec. 18. Data Collection of In-Field Agricultural Practices – Three Year Pilot Project.

In 2015, the Iowa Legislature provided funds to Iowa State University's College of Agriculture and Life Sciences (CALS) for purposes of supporting a three-year data collection of in-field practices project. The legislation identified three primary objectives, identified below, and required a progress report to be provided to the General Assembly March 1 of each year.

Objective 3: The college shall enter into a private-public partnership with one or more persons responsible for receiving, collecting or holding data described in bill.

- In the summer and fall of 2015, a request for proposals was issued by the college for the private partner with the capacity required. After a proposal review and interview process, the Iowa Nutrient Research and Education Council (INREC) was selected as the private partner, and a contract finalized and signed contract between INREC and the College of Agriculture and Life Sciences.
- INREC is a private nonprofit organization affiliated with the Agribusiness Association of Iowa (AAI), and as such has strong collaboration with AAI's network of over 1,100 members, which includes over 130 agricultural retailers and over 5,000 associated crop advisers. In addition to AAI's networks, the INREC Board of Directors is strategically structured to represent major farm and commodity organizations together with major fertilizer and crop production companies, ag retailers and crop advisers. INREC offers unique consolidated access to networks of agricultural professionals and farmer members to promote and assist with the organization's efforts.

Objective 2: Develop a database of in-field agricultural practices and analyze the impact of those practices in the aggregate.

Phase 1 Pilot Accomplishments (2015-2016), See Appendix 1 for more detail:

- Secure web server and data security consultant are in place.
- Working with ISU statisticians to validate sampling techniques and survey instrument
- Completed design and development of online data collection system.
- Development of data collection questions completed, which was coordinated with input from ISU Nutrient Science Team
- Beta test survey with small set of crop input providers and farmers completed.

Phase 2 Pilot Status & Plans (2016-2017):

- Following the beta test of electronically requesting survey input, the INREC project team held several in-person meetings with ag retailers from the test group to discuss the progress tracking system and the need for their assistance. All retailers expressed a strong willingness to support the work, but recognized that they could benefit from having a more dedicated point of contact assigned to working on it within their companies.

- Results from retailer meetings and their feedback was generally that the web-based collection system works well, and retailers have informational records available although more information about those is needed. Those who completed the survey with their customers noted no issues with obtaining farmer consent.
- In the fall of 2016 discussions were initiated with the ISU Science Team about generating a mock results dataset for the survey that could be utilized to help the science team test out making load reduction calculations based on the type of information that the survey will generate. Work on the mock dataset continues to progress, with results anticipated in spring 2017.
- Phase 1 of testing provided proof of concept for the survey questions. While Phase 1 showed the web based survey system with tokens works, that the system is easy to use, and that much of the data is available, Phase 2 will work to expand the number of responses to provide a more comprehensive test of scalability and how the process will work at the retailer level. We expect this to vary from business to business, but with a larger sample size and a larger number of retailers involved, we will be able to see what on the ground processes work well and how the retailers are best able to accomplish the task. This will help us to provide feedback to the retailers to help them be as efficient as possible. Efficiency will be critical once the pilot becomes both full scale and randomization is introduced in Phase 3. Phase 2 is targeted for completion by June 2017.
- During the first phase of the pilot project, we learned that acquiring the data points will require more direct personnel interactions and access for questions and help to the retailer. INREC has a staff of roughly 1.25 FTE, so to provide adequate resources to acquire data from what will eventually be more than 600 ag retail locations, three regional liaisons have been hired. These positions will function as independent contractors working on a part-time basis whose primary role will be to establish relationships with all ag retail companies across Iowa and work with them to recruit designated points of contact from each company to fill out the progress tracking survey. The liaisons will provide INREC with the ability to reach retailers across the state and provide them with in-person assistance to explain the work both to the retailer and their farmer customers, and assist retailers with completing the survey in a timely manner. Duration of the positions is estimated at 12 months, with future need being determined on the results and feedback received.

Phase 3 Pilot Plans (2017-2018):

- Phase 3 is targeted to commence in July 2017 and will be focused on collecting information for the 2016 crop year on in-field practices.
- Phase 3 will involve an expansion to statistically representative sampling conducted at full sampling scale needed to collect a representative sample and will introduce full randomization of sampling protocols.
- The targeted outcome for phase 3 is finalization of system design for the ongoing future progress measurement system.

<u>Objective 1: Enhance this state's ability to track its progress in reducing the transport of nutrients to water from nonpoint sources within watersheds…..</u>

Phase 1 (2015-2016), See Appendix 2 for more detail.

- In February 2016, CALS hired a full-time measurement coordinator to work with IDALS and IDNR to compile and prepare the annual Nutrient Reduction Strategy report to the Governor. The coordinator gathers information from Water Resource Coordinating Council (WRCC) agencies and Watershed Planning Advisory Council organizations that go into the report.
- The reporting process follows a Logic Model (Figure 1) approach and reports on key indicators in four categories to track progress in reducing the transport of nutrients to water.

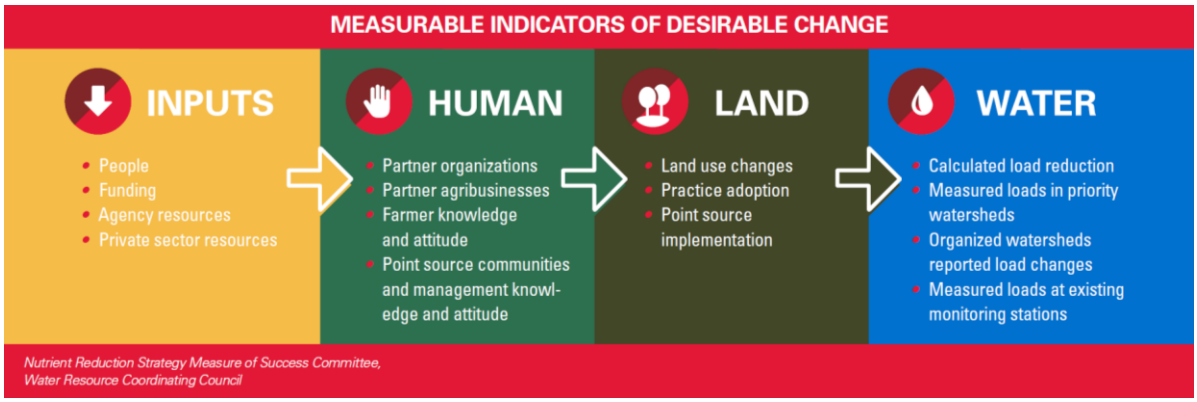

Figure 1. *The Logic Model of the Iowa Nutrient Reduction Strategy, guided by measurable indicators of desirable change.*

- The information collected includes publically available data from multiple sources in different formats for Inputs and Land indicators. The measurement coordinator is working with agencies and faculty to standardize data collection and reporting format.
- Efforts began in 2016 to standardize the information reported by Iowa Water Quality Initiative (WQI) project coordinators. In partnership with Iowa Department of Agriculture and Land Stewardship (IDALS), ISU is developing digital data collection tools that produce standardized information about coordinators' efforts in their watershed projects.
- Partnerships between the Natural Resources Conservation Service (NRCS), IDALS, and ISU have facilitated the availability of these datasets for NRS reporting. However, these cost-share data have significant limitations that must be addressed in order to develop more robust reporting of NRS progress in the future. Progress is being made to address the challenges.
- Part of the Human indicators involves surveying farmers systematically across the state over a five-year period. In 2015 and 2016, the survey received relatively high rates of response. Upon the completion of five years of data collection, this survey project will have provided sufficient data to explore two research questions. First, have Iowa farmers' knowledge, attitudes and behaviors changed from 2015 to 2019? Second, has more positive change occurred in priority watersheds, when compared with nonpriority areas?
- Also, in late 2015 a half-time communication specialist was hired to improve prepare the annual and supplemental progress reports on the NRS.

Phase 2, 2016-2017 Continuation of efforts started in year 1.

- It was identified that cost-share datasets do not provide the parameters that would allow researchers to accurately estimate the effectiveness of newly implemented practices. Through the partnership between ISU, NRCS, and IDALS, we are working to address these limitations. The necessary parameters for calculating nutrient loss reductions have been identified, and these agencies have begun communicating and collaborating to eventually improve or supplement the cost-share datasets for the purpose of tracking NRS progress.
- Analysis of the farmer survey data collected in 2015 and 2016 began. The data are initially summarized by year and watershed. Work is underway to evaluate the change over time in indicators and what influences knowledge, attitude and behavior including whether the farmer is in a WQI watershed or not. the methodology and results will be submitted as a scientific research article for peer-review in 2017. Surveys for the third year of the project were mailed in early 2017.
- Results from the farmer survey is helping to inform educational programming and discussions with partners in the public and private sector on how to more effective influence farmer decisions.

Appendix 1. *INREC Section for 2017 ISU Legislative Report*

Iowa Nutrient Research & Education Council Overview:
The Iowa Nutrient Research & Education Council (INREC) is a private non-profit organization strategically structured to represent major farm & commodity organizations together with major fertilizer and crop production companies, ag retailers and crop advisers which provides unique consolidated access to their networks of ag professionals and farmer members to promote and assist with INREC efforts.

INREC has three core missions focused on measuring and demonstrating environmental progress, fostering innovation and development of new technologies, and enhancing crop adviser and ag retailer roles as "change agents" working with Iowa farmers to achieve environmental goals.

Environmental Progress Measurement & Demonstration – Collaborate with agronomy retailers, crop advisers, and ISU scientists to develop and pioneer a first-of-its-kind progress measurement system using ag retailer and crop adviser farm records to track environmental progress being made by Iowa farmers and calculate nutrient load reductions in the same units of measurement as that by cities and industries.

New Technology, Research & Water Quality Performance Validation – Many environmental products, practices and services exist and are forthcoming in the marketplace which have not been fully subjected to neutral science testing to validate environmental performance and benefits. INREC will help facilitate and achieve neutral science-based performance validation to help foster innovation of new technologies and expansion of science-based options for meeting water quality goals. Science leadership will be by the College of Agriculture and Life Sciences, Iowa State University.

Enhance Environmental Impact of Ag Retailers & Crop Advisers – The existing roles of Iowa's ag retailers, 1300 certified crop advisers, and estimated 5000 total advisers who essentially "meet with every farmer, concerning every field, every year" will be enhanced by providing increased outreach and training to help with advising farmer decisions regarding environmental technologies and practices.

Through these combined efforts, INREC will serve to demonstrate progress, foster innovation of new technologies, and enhance crop adviser and ag retailer roles as "change agents" working with Iowa farmers to achieve environmental goals.

INREC Progress Measurement System – Background & Development Framework:

The Iowa Nutrient Reduction Strategy specifically calls for the creation of a public/private partnership for tracking progress as detailed in the following excerpt from the NRS. This partnership will provide for a system capable of accurately tracking progress by providing quantifiable metrics of tons/year nutrient reductions for nonpoint sources which will provide for comparable measures as will be used by point sources to quantify nutrient load reductions – thereby giving Iowa the status of being the first state to measure nonpoint source and point source progress in the same terms.

(excerpt p. 25, Iowa Nutrient Reduction Strategy rev October 1, 2014)
"Regarding nonpoint sources, develop new and expanded frameworks to track progress, beyond the traditional ambient water quality monitoring networks. Encourage expansion of geographic coverage and frequency of statistical surveys that characterize on farm actions to adopt nutrient reduction practices… develop new frameworks through ag retailers and CCAs to characterize farmer and landowner adoption of new technologies and practices that reduce nutrient transport to water from nonpoint sources… establishment and refinement of a public/private reporting system that documents nutrient management and conservation system application within watersheds… private sector tracking system of conservation practices, structures, fertilizer sales and other farm inputs and outputs… privacy rights of individual farms shall be maintained…"

INREC was selected as the private partner and awarded a 3 year grant in response to a request for proposals by ISU. In partnership with ISU, INREC is conducting a 3-year pilot project to develop, refine and establish the processes for carrying forward full-scale efforts to collect, verify, manage, and aggregate ag retailer data on agricultural nutrient management practices for the purpose of quantifying nutrient load reductions stemming from farmer activities across Iowa.

INREC is providing for the project needs to achieve these goals by tapping into AAI's network of over 130 agricultural retailers and over 5,000 associated crop advisers to report information on their farmers' use of conservation practices. This network of retailers and advisers has an unprecedented footprint with Iowa farmers as they meet with virtually every farmer, about every field, every year and possess valuable information in their records about farmer use of conservation practices.

The framework for data collection consists of an online survey that retailers will utilize to enter information from their records about farmer use of practices. Sampling procedures for data collection will be conducted in a statistically valid manner, with randomized sampling, to provide for a representative sample that accurately characterizes the use of NRS practices by farmers across Iowa. The highest level of data security firewalls are being maintained and audits of the data collection will be performed to validate accuracy of information reported. Data will be aggregated in a manner to protect individual confidentiality while providing ISU with information enabling them to calculate nutrient load reductions.

INREC Progress Measurement System Pilot Project Status & Future Plans

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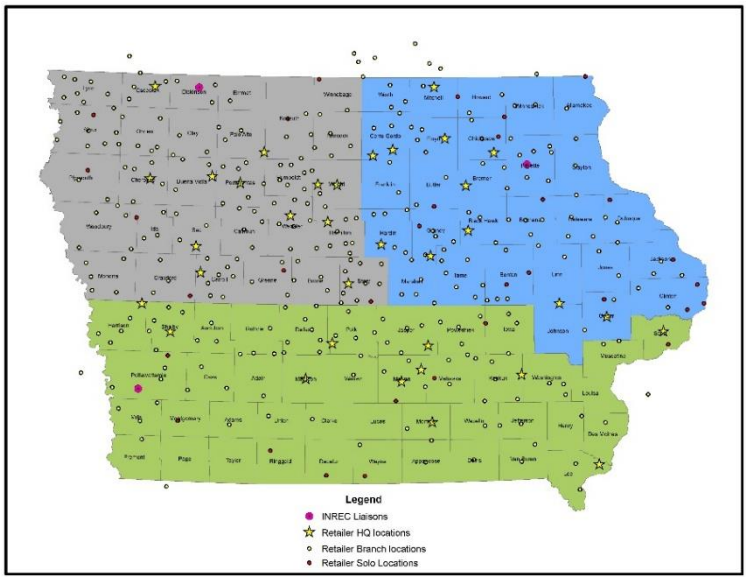
Map of ag retailers and INREC regional liaison areas:



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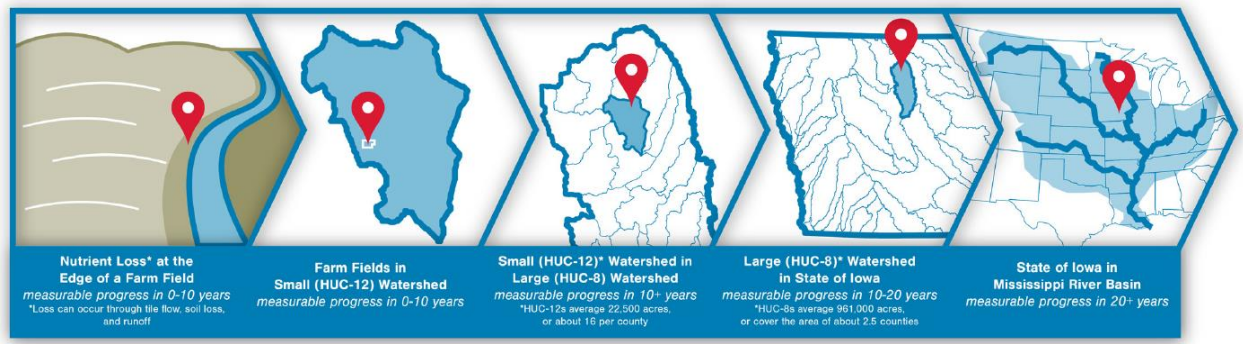
Need for Near-Term Progress Measures:

The inherent need for the progress tracking system that INREC is developing is to create a progress tracking system able to provide near-term assessments of the impact of efforts being carried out to implement the Iowa Nutrient Reduction Strategy. While there are several existing water quality monitoring locations across Iowa, these are mostly located to sample very large watersheds with relatively infrequent samples. Both the large scale and infrequent sampling, compounded by climatic variables at large scale, make this type of metric insufficient for measuring year-to-year changes in the impact that practices are having. As illustrated by the graphic below which is from the "Iowa Nutrient Reduction Strategy - Stream Water Quality Monitoring in Iowa" report, the larger the scale of monitoring, the longer it generally takes to be able to detect statistically significant changes and trendlines in water

quality. The INREC progress tracking system allows us to better assess year-to-year changes by collecting a representative sample of the practices being used by farmers across the state and then using those aggregate results to calculate the resulting load reductions for N and P based on the best available science in the NRS which summarizes the water quality performance of practices based on numerous years of scientific research conducted across variable climatic and environmental conditions, and as such provides an accurate assessment of the impacts that practices will have on reducing nutrient loads which already incorporates this type of variability.



Additional Progress Measurement Activities Funded by INREC (Not Funded Through State Appropriations or ISU Grant):

1. ***Agribusiness Association of Iowa Ag Retailer Survey***

The Agribusiness Association of Iowa conducted a survey of ag retailer members in the late fall of 2015 asking for their insights into the nutrient management and conservation activities of their customers to help characterize the status of farmer efforts across Iowa. The survey did not ask for any feedback about individual farmers, rather it relied on the experience and knowledge that ag retailers and crop advisers possess about their customers as a whole thanks to the large presence they have working with virtually every farmer, in every field, every year. The 17-question online survey was sent to over 130 AAI ag retailer members and received a 45% response rate which represented a total of 50,631 farmers and 18,469,250 acres. The full report and survey results can be accessed at http://agribiz.org/wp-content/uploads/2016/10/2016_retailer_survey_final.pdf.

Summary of Key Findings:

Overall, the survey findings provide valuable information about the "lay of the land" on farmer use of several nutrient management and conservation practices, and shows how ag retailers are assisting with those efforts in the services they provide. Here are some key findings from the survey:

- Ag retailers have responded impressively to offer numerous services that have benefits for both crop productivity and environmental objectives.
- 100% of retailer responses indicated that they offer soil sample collection, and 92% offer soil sample nutrient analysis.
- 88% of retailers sell seed for cover crops, and 73% offer seeding services to plant cover crops.
- The largest areas of potential interest in retailer service offerings are for UAV use in agriculture and for conservation planning services, showing that retailers are responding well to what their customers have shown strong interest in and demand for as markets emerge.
- Nearly equal amounts of farmers apply their nitrogen in a single application as those that apply their nitrogen in split applications.
- The majority of farmers are applying their nitrogen at rates that fall within ISU guidelines.

- The vast majority of farmers use soil tests to inform their phosphorus application rate.
- A large percentage of farmers utilize variable rate technology to apply their phosphorus.
- Less intensive tillage methods (e.g. no-till, conservation tillage) were the most common methods for tillage prior to both corn and soybeans, while intensive tillage such as using a moldboard plow was the least utilized method.
- Farmer use of agronomy decision support tools shows strong adoption of technologies that help inform them about nutrient management and productivity goals.
- Farmer use of conservation planning ranked equal to or greater than many of the decision tools used by farmers to inform them about their productivity and inputs.

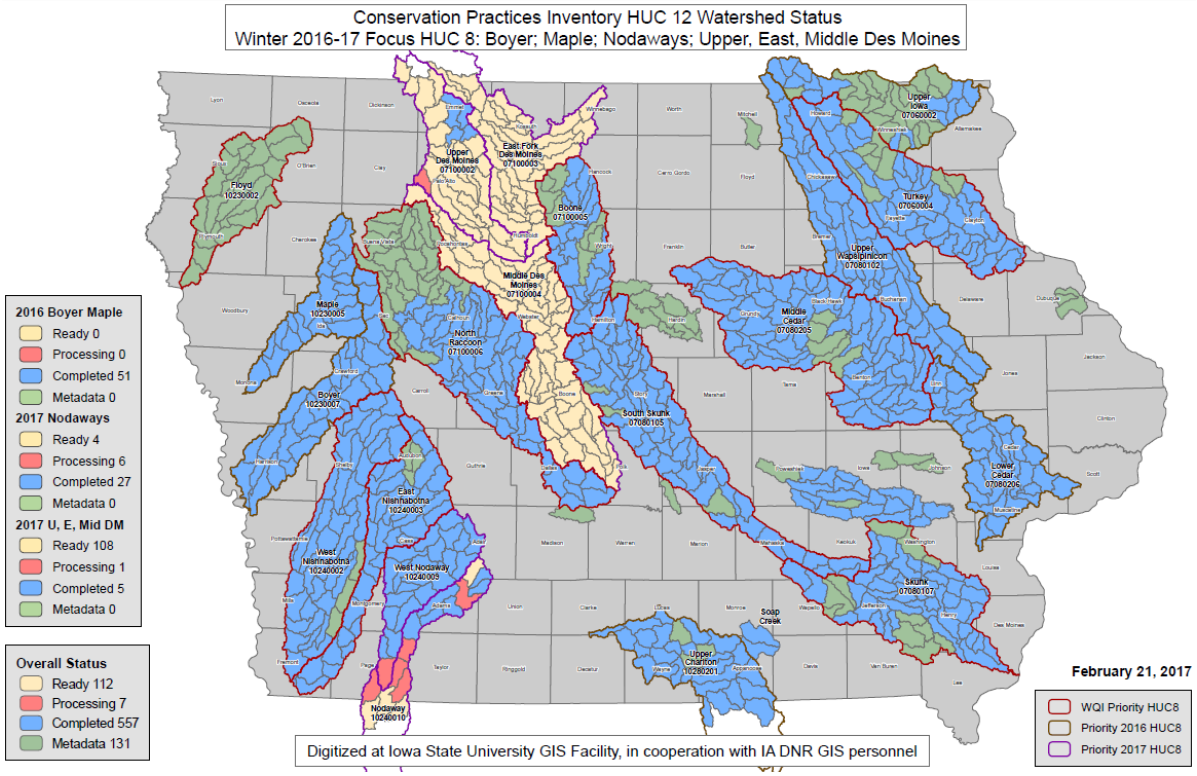
2. Geographic Information Systems Mapping of Structural Conservation Practices

This project utilizes GIS technology and high accuracy digital elevation data along with aerial imagery to provide an accurate inventory of 6 best management practices (terraces, grassed waterways, ponds, water & sediment control basins, contour buffer strips, and strip-cropping) across the state of Iowa which will provide valuable information on the existing conditions of these practices and the ability to track changes in practice use over time.

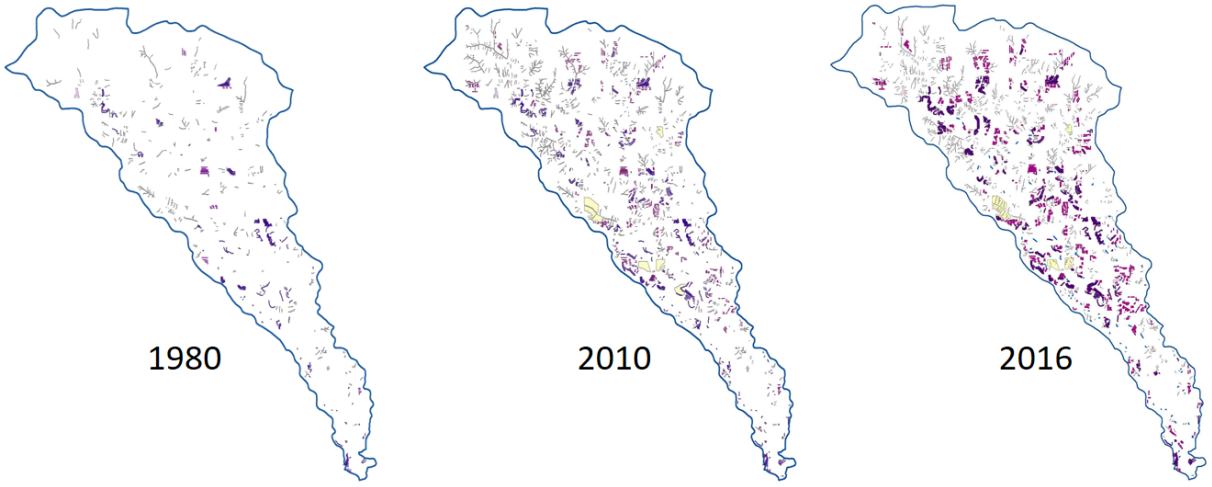
Benefits Provided by GIS mapping of practices:

- Paints the whole picture of what practices exist – Blind to private or public $ source
- Establishes recent baseline to compare against past and future
- Can estimate nutrient load reductions from level of practices based on NRS science
- Can estimate level of conservation infrastructure investment
- Visibly demonstrates the level of practices in watersheds
- Provides a uniform, consistent database to work from through a state vetted process

Beginning in State Fiscal Year 17, INREC has been providing the only private funding to assist with this project to complete the mapping for all HUC12 watersheds in Iowa. INREC is also providing private funding to assist with assessing the historic presence of practices in mapped watersheds to determine changes in practice levels from past to present. The historical analysis will be done on 20-25% of the HUC12 watersheds in each HUC8 watershed in Iowa as the base mapping is completed. To date, 43% of the base mapping of practices for the state has been completed as illustrated by the map below.



Example HUC12 Watershed Map Showing Changes in Practice Use Over Time:



Practice	1980	2010	2016
Ponds	35	59	67
Terraces	96	232	319
WASCOBs	48	479	780
Grassed Waterways	308	869	1,064
Contour Buffers	0	8	7
Stripcropping	NA	None	None

3. ***Estimate of Historic N & P Nutrient Loads for Nonpoint Sources***

INREC is providing financial assistance to ISU to conduct an assessment of historic nutrient load exports of N and P from Iowa. This assessment is being conducted by the same team of scientists that produced an estimate of recent nutrient load exports at the time (~2007-2010) the Iowa NRS was developed. The ISU team is assessing existing historical datasets and replicating the same procedures used for estimating current nutrient load exports from Iowa in order to estimate what nutrient export levels were around the 1980-1996 period, which is consistent with the reference period used by the Gulf of Mexico Hypoxia Task Force and other states neighboring Iowa. A final report will document the results showing how nutrient loads for N and P have changed over time.

Appendix 2, Public partner report on progress to date

Introduction

The Iowa Nutrient Reduction Strategy (NRS) is a research- and technology-based approach to assess and reduce nutrients delivered to Iowa waterways and the Gulf of Mexico. The strategy outlines opportunities for efforts to reduce nutrients in surface water from both point sources, such as wastewater treatment plants and industrial facilities, and nonpoint sources, including farm fields and urban areas, in a scientific, reasonable, and cost-effective manner.

The NRS was developed in response to United States Environmental Protection Agency (EPA) recommendations provided in their March 16, 2011, memo, "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reduction." The Annual Progress Report provides updates on point source and nonpoint source efforts related to action items listed in the elements of the strategy and updates on implementation activities to achieve reductions in nitrogen and phosphorus loads. The NRS documents, including each year's annual progress report, can be accessed at http://nutrientstrategy.iastate.edu/.

Improved assessment of progress has been deemed crucial to the success of the NRS. Measurement of the barriers to and progress in NRS implementation will help inform management decisions in this multi-faceted and highly collaborative approach to nutrient load reduction in Iowa.

The 2015 Iowa Legislature approved funding to the College of Agriculture and Life Sciences (CALS) at Iowa State University for purposes of supporting a three-year data collection of in-field practices project. In general, the objectives are to:

- Enhance this state's ability to track its progress in reducing the transport of nutrients to water from nonpoint sources within watersheds.
- Develop a database of in-field agricultural practices and analyze the impact of those practices in the aggregate.
- Enter into a private-public partnership with one or more persons responsible for receiving, collecting, or holding data in accordance with the legislation and protecting the confidentiality of the data.

This report serves as an annual update of progress for this NRS Measurement Pilot Project.

Background: The Logic Model Approach to Measuring Progress

The 2015 annual progress report of the NRS introduced the "logic model" framework as the basis of considerations set forth by the WRCC Measures Subcommittee. The Logic Model is guided by

measurable indicators of desirable change that can be quantified, and represents a progression towards goals for achieving a 45 percent reduction in nitrogen and phosphorus loads. This development of a measurement framework assists the annual reporting process, which was recommended by the 2011 EPA memo.

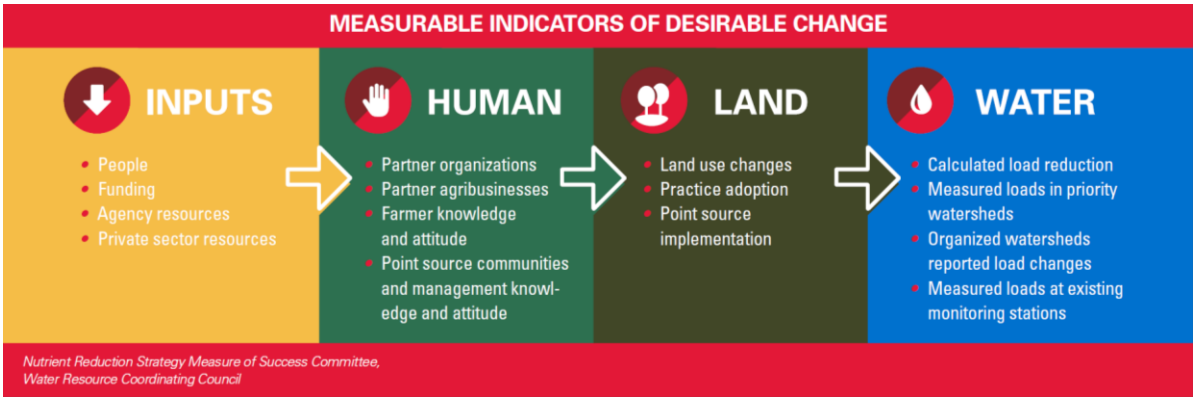


Figure 2 The Logic Model of the Iowa Nutrient Reduction Strategy, guided by measurable indicators of desirable change.

A significant reduction in nutrient loads is the ultimate goal of the NRS, and is represented by the right-most category of Figure 1. In order to affect change in water quality, there is a need for increased inputs, measured as funding, staff, and resources. Inputs affect change in outreach efforts and human behavior. This shift toward more conservation-conscious attitudes in the agricultural community is a desired change in the human dimension of water quality efforts. With changes in human attitudes and behavior, changes on the land may occur, measured as conservation practice adoption and wastewater treatment facility upgrades. Finally, these physical changes on the land may affect Iowa's surface water nutrient load, which ultimately can be measured through both empirical water quality monitoring and through modeled estimates of nutrient loads in Iowa surface water. The measurable indicators that correspond to each category, as outlined in Figure 1, provide quantified parameters in which to track year-to-year changes and continual trends to develop a standardized protocol for evaluating NRS progress.

In measuring progress of the NRS, the logic model serves as a comprehensive reporting tool to inform data collection, indicator development, and assessment of the successes and challenges associated with reducing nutrient loads from point and nonpoint sources. The logic model guides the assessment of not only a progression of changes, but also can inform improvements in each of the four primary categories. With continually refined measurement of each category, potential adjustments may be made to the inputs and efforts that partner organizations devote to the NRS in order to impact change over time.

Updated Methods to Address Challenges in NRS Measurement

During the 2017 reporting period for the NRS Measurement Pilot Project, there have been a few key changes to the NRS measurement approach. These updates—including partnerships, data standardization, and farmer surveys—are outlined as follows.

WRCC/WPAC Involvement

The Water Resources Coordinating Council (WRCC) and the Watershed Protection Advisory Committee (WPAC) contribute significantly to NRS measurement efforts. In 2016, partnerships with these agencies, universities, private companies, and NGOs facilitated data collection. Organizations within the WRCC and the WPAC have participated for two years in ongoing data collection efforts. 2016 participating organizations are listed in

Table ***1***. The data collected through this partnership have allowed for tracking of funding, staff full-time equivalents, outreach activities, and water monitoring sites. In 2016, the survey was adapted with some key improvements that standardize the data submitted. This survey will be conducted annually to continue tracking these indicators.

Table 1 Partner organizations that submitted reports on NRS-related efforts for the 2016 reporting period.

Water Resources Coordinating Council
Environmental Protection Agency - Region 7
Farm Service Agency
Iowa Department of Agriculture and Land Stewardship
Iowa Department of Natural Resources
Iowa State University - College of Agriculture and Land Stewardship
Natural Resources Conservation Service
University of Iowa - College of Engineering
Watershed Planning Advisory Council
Conservation Districts of Iowa
Iowa Corn Growers Association
Iowa Environmental Council
Iowa Farm Bureau Federation
Iowa Pork Producers Association
Iowa Soybean Association
Other Valued Partners
Agriculture's Clean Water Alliance
Iowa Agricultural Water Alliance
The Nature Conservancy
Trees Forever

Standardization of Water Quality Initiative Reports

The Iowa Water Quality Initiative (WQI) provides funding and support to small-scale watershed projects. These project serve as demonstrations and innovative approaches to NRS implementation by distributing cost-share funding for agricultural and urban conservation practices. Efforts began in 2016 to standardize the information reported by Iowa Water Quality Initiative (WQI) project coordinators. In partnership with Iowa Department of Agriculture and Land Stewardship (IDALS), ISU is developing digital data collection tools that produce standardized information about coordinators' efforts in their watershed projects. Previous WQI projects' quarterly were effective for recording progress updates. However, the new data collection tools will provide a more standardized approach to gathering information on projects' outreach and education activities. The primary intention of these developments is to demonstrate progress of local efforts across Iowa—supplementing the annual statewide reporting—by tracking the indicators outlined in the Logic Model (Figure 1). However, these efforts will serve the additional purpose of informing efforts to better understand the outreach strategies that have contributed to various projects' successes. Data have been collected and compiled that reflect the second quarter of this fiscal year (October to December 2016); data collection will continue on a quarterly basis.

State and Federal Cost-Share Data: Challenges and Strategies

Administrative datasets for cost-share programs—both state and federal—comprise an invaluable data source for tracking the adoption of conservation practices in Iowa. These datasets provide a reasonable understanding of the extent to which certain practices have been implemented throughout Iowa each year to reduce nonpoint source nutrient loss. Partnerships between the Natural Resources Conservation Service (NRCS), IDALS, and ISU have facilitated the availability of these datasets for NRS reporting. However, these cost-share data have significant limitations that must be addressed in order to develop more robust reporting of NRS progress in the future.

First, there are inconsistencies and, to a small extent, errors that reduce the accuracy of reporting practice adoption. A primary inconsistency is the lack of standard units for reporting each practice. NRCS reports some practices in different units than does IDALS, so calculating total implementation requires estimation or conversion of units.

Second, the extent of overlap between the state and federal datasets is unknown. It is possible that a landowner could concurrently receive federal and state funding, but the datasets do not provide identification of these potential cases of overlap. Thus, estimated total implementation of a practice—by adding state and federal contracts—could result in inflated annual estimates.

Third, the cost-share datasets do not provide the parameters that would allow researchers to accurately estimate the effectiveness of newly implemented practices. Researchers at ISU and Iowa Department of Natural Resources (DNR) aim to model the reductions in nutrient loss affected by practices. However, this model would produce more robust estimates if more parameters were reported for most practices. For instance, the volume of soil held in place by a terrace would be consistent with the model's requirements for calculating phosphorus loss reductions, but this parameter is not reported in the federal dataset.

Through the partnership between ISU, NRCS, and IDALS, we are working to address these limitations. The necessary parameters for calculating nutrient loss reductions have been identified, and these agencies have begun communicating and collaborating to eventually improve or supplement the cost-share datasets for the purpose of tracking NRS progress.

Measuring change in farmers' knowledge, attitude, and conservation behaviors

Iowa State University Sociology Extension, with funding from IDALS, is conducting a five-year survey of farmers across Iowa to track potential changes in NRS knowledge, attitudes, and conservation practice use over time. Surveys have been collected for two years, and the third year's surveys have been distributed.

The farmer survey project is implemented over a five-year period through an annual rotating longitudinal survey that will cover six watersheds of hydrologic unit code 6 (HUC6) size, containing HUC8 watersheds that have been identified as "priority watersheds" for the NRS. Within each of these HUC6 watersheds, a priority HUC8 will be surveyed as the "treatment" watershed. This approach will allow comparison, within each of the HUC6 watersheds, between priority HUC8 watersheds where demonstration projects are funded, and the rest of the HUC8 watersheds within those HUC6 watersheds that have not received a priority designation. The HUC6 watersheds and their priority HUC8 watersheds are listed in

Table *1*

Table 2 HUC6 and priority HUC8 watersheds within the HUC6 watersheds.

HUC6 Watershed	Priority HUC8 Watershed(s)
Iowa	Middle Cedar
Missouri-Little Sioux	Floyd
Upper Mississippi-Maquoketa-Plum	Turkey
Upper Mississippi-Skunk-Wapsi	South Skunk & Skunk
Missouri-Nishnabotna	West Nishnabotna East Nishnabotna
Des Moines	Boone & North Raccoon

In 2015 and 2016, the survey received relatively high rates of response (Table 3). Upon the completion of five years of data collection, this survey project will have provided sufficient data to explore two research questions. First, have Iowa farmers' knowledge, attitudes, and behaviors changed from 2015 to 2019? Second, has more positive change occurred in priority watersheds, when compared with non-priority areas?

Table 3 Number of respondents and average response rate of the HUC6 watersheds surveyed in 2015 and 2016.

		HUC6 Total Respondents		**HUC6 Average Response Rate**	
HUC6	*Priority HUC8*	***2015***	***2016***	***2015***	***2016***
Iowa	*Middle Cedar*	940	197	48%	40%
Missouri-Little Sioux	*Boyer*	782	175	45%	34%
Upper Mississippi-Maquoketa	*Turkey*		888		44%

In collaboration with the Iowa State University Center for Statistics & Methodology, researchers are conducting statistical analysis of the survey results on an ongoing basis. Analysis of the 2015 and 2016 data has been conducted; the methodology and results will be submitted as a scientific research article for peer-review in 2017.

The study evaluates the effect of some explanatory variables on knowledge, attitude, and behavior. These explanatory variables are as follows:

1) Information sources from which the respondent learned about NRS (public, private, or general press);
2) Respondent's involvement in formal watershed management activities;
3) Respondent's receipt of cost-share and/or technical assistance in the previous five years;
4) The sources or groups that influence the respondent's nutrient management decision (public, private, NGO, or social).

The following highlighted results reflect significant findings from the 2015 and 2016 surveys. First, the following variables were significantly associated with increases in farmers' level of NRS knowledge: Private information sources, public information sources, general press as an information source, public groups' nutrient management influence, and NGOs' nutrient management influence. Alternatively, private groups' nutrient management influence was significantly associated with decreases in farmers' level of NRS knowledge.

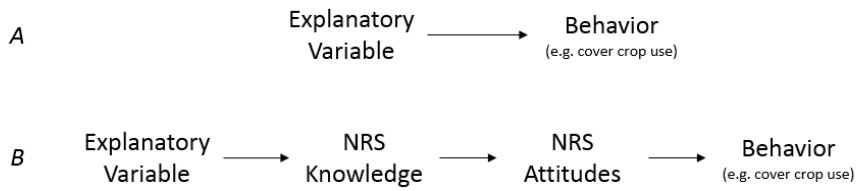


Figure 3 The causal pathway models that are assessed for the 5-year NRS Farmer Survey.

The analysis also examined these variables' causal effects on farmers' conservation behavior (i.e. whether the respondent used specified practices during the season prior to filling out the survey). Initial results focus on the effects on cover crop use. In other words, we aim to answer the question, "Did any of these explanatory variables have a causal effect on a farmer's likelihood of having used cover crops?" We have examined the direct effects (Figure 3, pathway A), and the indirect effects through affecting NRS knowledge and attitudes (Figure 3, pathway B). Both watershed involvement and the use of cost-share or technical assistance had a significant and positive *direct* causal effect on the likelihood of cover crop use. However, when mediated through the effects on knowledge and attitude, the following variables showed a positive *indirect* causal effect on cover crop use: public information sources, the general press, public groups' nutrient management influence, watershed group involvement, and the use of cost-share or technical assistance. However, private groups' nutrient management influence had a negative indirect effect on cover crop use.

These results begin to highlight the implications of spreading awareness and encouraging positive attitudes toward the NRS among Iowa farmers. The survey responses suggest that knowledge and attitude play a part in increasing farmers' likelihood of using, and perhaps newly adopting, conservation practices that reduce nutrient loss. In addition, farmers look to many different agencies and organizations for information and nutrient management advice; these results suggest that partnerships and shared goals—among public, private, and NGO groups—will likely play important roles in farmers' NRS participation.

Analysis of survey responses will continue for the next three or more years. Status reports will be released on an annual basis, and will be available through ISU Extension.[1]

Reporting and communicating progress

In the last year, the NRS Measurement Pilot Project has worked toward improved reporting and communications. With a full-time measurement coordinator and a half-time communications specialist hired by ISU in December 2015, reporting has centered on the NRS Annual Progress Report and supplemental reports, which are available at the NRS website: http://nutrientstrategy.iastate.edu/ . The 2016 NRS Annual Progress Report incorporated the tracking efforts outlined above. With a new standardized approach to tracking and reporting progress, indicators of progress will be consistently evaluated on an annual basis in the coming years.

In addition to the annual report, DNR coordinated a multi-stakeholder report that documents and evaluates the existing stream water-quality monitoring efforts that are currently conducted in Iowa. This report, which was released in August 2016 and is available at the NRS website, serves as a working document. Future changes in Iowa's water-quality monitoring network will be incorporated into revisions of the report and will facilitate an evolving understanding of the network's utility in tracking progress toward Iowa's nutrient reduction goals. A two-page summary of this report is also available at the NRS

[1] https://store.extension.iastate.edu/

website. Communications teams at DNR, IDALS, and ISU produced a collaborative press-release that publicized the release of this report and its corresponding summary.

Key remaining challenges

Through these efforts to build partnerships, assess farmers' likelihood of using conservation practices, and identify opportunities in tracking conservation practices, the Measurement Pilot Project has made strides in improved reporting for NRS progress. However, we have identified some key challenges that we hope to address in the near future.

First, as outlined above, cost-share data present significant limitations for tracking conservation practices. In the coming reporting period, we will aim to continue collaboration with NRCS and IDALS to further the conversation about data needs. In their current states, these federal and state datasets are not designed for NRS tracking; significant changes in data collection and reporting will be required for improved utility of these datasets.

Second, we will aim to create communications materials that are public-friendly, concise, and readily available for stakeholders interested in learning more about NRS progress. While annual reports and technical documents will continue to be housed on the NRS website, collaboration between ISU, DNR, and IDALS communications teams will draft supplementary communications strategies in Spring 2017.